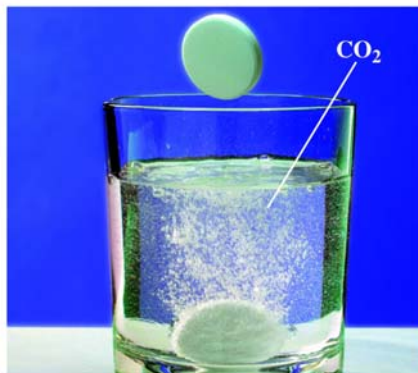


Chapter 8

Chemical Quantities in Reactions



NaHCO₃

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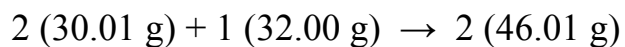
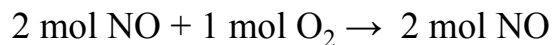
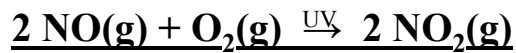
Fe

Fe₂O₃

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Conservation of Mass

- The *law of conservation of mass* states that mass is neither created nor destroyed during a chemical reaction. Lets test:

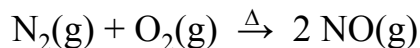


$$\boxed{92.02 \text{ g} = 92.02 \text{ g}}$$

- The mass of the reactants is equal to the mass of the product! Mass is conserved.

Mole - Mole Relationships

- We can use a balanced chemical equation to write mole ratios which can be used as unit factors:



- Since 1 mol of N_2 reacts with 1 mol of O_2 to produce 2 mol of NO , we can write the following mole relationships:

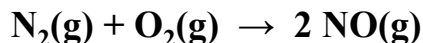
$\frac{1 \text{ mol N}_2}{1 \text{ mol O}_2}$	$\frac{1 \text{ mol N}_2}{2 \text{ mol NO}}$	$\frac{1 \text{ mol O}_2}{2 \text{ mol NO}}$
$\frac{1 \text{ mol O}_2}{1 \text{ mol N}_2}$	$\frac{2 \text{ mol NO}}{1 \text{ mol N}_2}$	$\frac{2 \text{ mol NO}}{1 \text{ mol O}_2}$

Chapter 8

3

Mole - Mole Calculations

- How many moles of oxygen react with 2.25 mol of nitrogen?



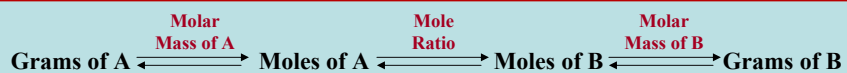
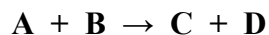
- **Step 1:** Check that the equation is balanced!!!
- **Step 2:** Determine what you have: 2.25 mol N_2
- **Step 3:** Determine what you want: ??? mol O_2
- **Step 4:** Write a plan to convert from what you have to what you want.
- **Step 5:** Select conversion factor(s) that allow you to complete your plan

Chapter 8

4

Mass - Mass Problems

- In a mass-mass stoichiometry problem, we will convert a *given mass* of a reactant or product to an *unknown mass* of reactant or product.
- There are four steps:
 - **Step 1:** Check that the equation is balanced!!
 - **Step 2:** Convert the given mass to moles using the molar mass as a conversion factor.
 - **Step 3:** Convert the moles of given to moles of the unknown using the coefficients in the balanced equation as a conversion factor.
 - **Step 4:** Convert the moles of unknown to grams using the molar mass as a conversion factor.



Mass-Mass Stoichiometry Problem

- What is the mass of mercury produced from the decomposition of 1.25 g of orange mercury (II) oxide (MM = 216.59 g/mol)?



- **Step 1:** Convert grams Hg to moles Hg using the molar mass of mercury (200.59 g/mol).
- **Step 2:** Convert moles Hg to moles HgO using the balanced equation.
- **Step 3:** Convert moles HgO to grams HgO using the molar mass.

Limiting Reactant Concept

- Say you're making grilled cheese sandwiches. You need 1 slice of cheese and 2 slices of bread to make one sandwich.



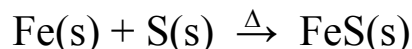
- If you have 5 slices of cheese and 8 slices of bread, how many sandwiches can you make?
- You have enough bread for 4 sandwiches and enough cheese for 5 sandwiches.
- You can only make 4 sandwiches; you will run out of bread before you use all the cheese.

Limiting Reactant

- Since you run out of bread first, bread is the ingredient that **limits** how many sandwiches you can make.
- In a chemical reaction, the ***limiting reactant*** is the reactant that controls the amount of product you can make.
- A limiting reactant is used up before the other reactants.
- The other reactants are present in ***excess***.

Determining the Limiting Reactant

- If you heat 2.50 mol of Fe and 3.00 mol of S, how many moles of FeS are formed?



- According to the balanced equation, 1 mol of Fe reacts with 1 mol of S to give 1 mol of FeS.
- So 2.50 mol of Fe will react with 2.50 mol of S to produce 2.50 mol of FeS.
- Therefore, iron is the limiting reactant and sulfur is the excess reactant.

Experiment	mol Fe	mol S	mol FeS
before reaction:	2.50	3.00	0.00
after reaction:	0.00	0.50	2.50

Mass Limiting Reactant Problems

There are three steps to a limiting reactant problem:

Step 1: Calculate the mass of product that can be produced from the first reactant.

mass reactant #1 \Rightarrow mol reactant #1 \Rightarrow mol product \Rightarrow mass product

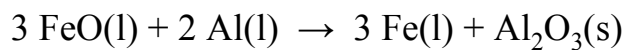
Step 2: Calculate the mass of product that can be produced from the second reactant.

mass reactant #2 \Rightarrow mol reactant #2 \Rightarrow mol product \Rightarrow mass product

Step 3: The limiting reactant is the reactant that produces the **least** amount of product.

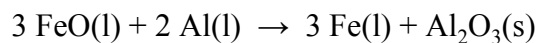
Mass Limiting Reactant Problem

- How much molten iron is formed from the reaction of 25.0 g FeO and 25.0 g Al?



- **Step 1:** Convert g FeO to g Fe:

Mass Problem Continued



- **Step 2:** Convert g Al to g Fe:

- **Step 3:** Lets compare the two reactants:

Percent Yield

- When you perform a laboratory experiment, the amount of product **collected** is the *actual yield*.
- The amount of product **calculated** from a limiting reactant problem is the *theoretical yield*.
- The *percent yield* is the amount of the actual yield compared to the theoretical yield.

$$\frac{\text{actual yield}}{\text{theoretical yield}} \times 100 \% = \text{percent yield}$$

Calculating Percent Yield

- Suppose a student performs a reaction and collects 0.875 g of CuCO_3 and the theoretical yield is 0.988 g. What is the percent yield?

